3. Green Hydrogen- Environment

"Energy storage, green hydrogen to fundamentally reshape India's renewable energy ecosystem". India has launched the National Green Hydrogen Mission to achieve an annual production of 5 MMT by 2030, aiming to decarbonize hard-to-abate sectors and reduce fossil fuel reliance. The initiative is supported by the SIGHT incentive scheme for domestic manufacturing, the development of coastal export hubs, and a new certification framework.

Context- Reshaping India's Energy Ecosystem

Over the next five years, the Indian energy landscape is set to undergo a fundamental transformation. Emerging technologies, specifically Energy Storage and Green Hydrogen, will be the primary drivers reshaping the renewable energy sector.

The Role of Green Hydrogen

Clean Fuel Alternative- It serves as a scalable, clean fuel capable of replacing fossil fuels.
Decarbonization- It is crucial for "hard-to-abate" sectors (industries where electrification is difficult, like steel, cement, and heavy transport).
Energy Security- By producing fuel domestically, India aims to drastically reduce its heavy dependence on imported fossil fuels.

The National Green Hydrogen Mission (NGHM)

Launched by the Indian government in 2023, this mission acts as the umbrella programme to establish a comprehensive ecosystem.

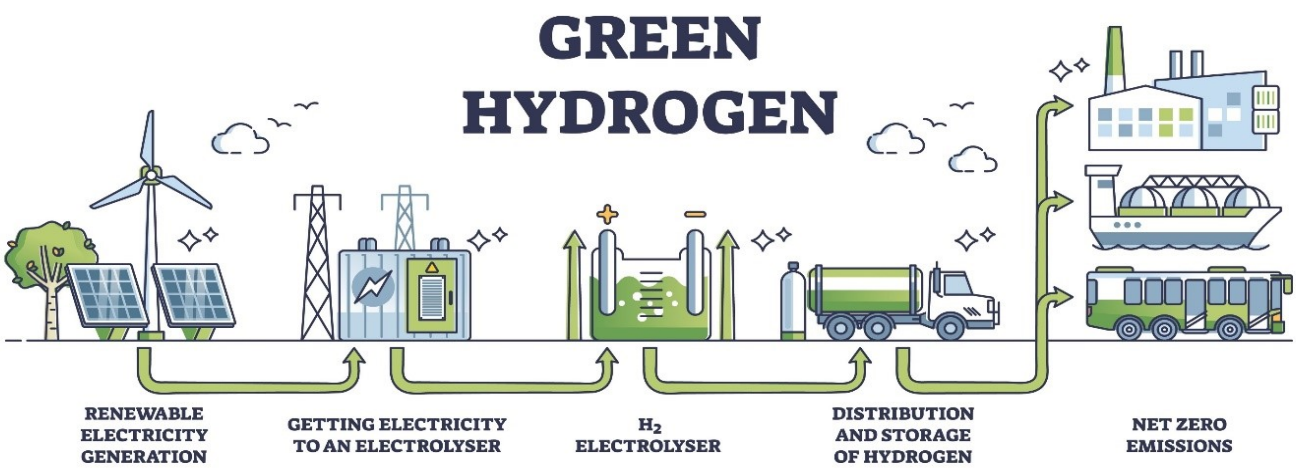
Key Targets

1. Production Goal- Achieve an annual production capacity of 5 Million Metric Tonnes (MMT) of Green Hydrogen by 2030.
2. Mobility Pilots- Implementation of hydrogen mobility projects across 10 routes, utilizing 37 vehicles (mix of Fuel Cell Vehicles and Hydrogen Internal Combustion Engines).

Four Key Pillars of the Mission

1. Policy and Regulatory Framework- Establishing clear rules to govern production and usage.
2. Demand Creation- Mandating consumption in specific industries to guarantee a market.
3. R&D and Innovation- Funding research to lower costs and improve technology.
4. Enabling Infrastructure- Building the necessary storage, transport, and ecosystem support.

Green Hydrogen- Understanding the distinction between Green Hydrogen and other forms is vital for policy interpretation.
Production Method- It is produced by splitting water into Hydrogen and Oxygen.
Energy Source- This process (electrolysis) is powered exclusively by renewable energy (Solar or Wind), rather than fossil fuels.
Biomass Route- It can also be produced by converting biomass (e.g., agricultural waste), provided emissions remain strictly limited.



"Green" Definition (Emission Limits)- To be certified as "Green," the total emissions must not exceed 2 kg of CO_2 equivalent per 1 kg of Hydrogen produced.

India's Broader Climate Targets

The Green Hydrogen Mission supports India's larger climate commitments.

Long-Term Vision- Net Zero- Achieve Net Zero Emissions by 2070.

Short-Term Goals (By 2030)

1. Capacity- Increase renewable energy capacity to 500 GW.
2. Energy Mix- Meet 50% of energy requirements from renewable sources.
3. Emission Reduction- Reduce cumulative carbon emissions by one billion tonnes.
4. Intensity Reduction- Lower the emissions intensity of GDP by 45% (from 2005 levels).

Current Status- Electricity Generation Mix

India has reached significant milestones in its power generation capacity.

Total Installed Capacity

Total Capacity- Surpassed the 500 GW mark, reaching 500.89 GW.

Comparison- Fossil vs. Non-Fossil Sources

Category	Capacity (GW)	Share of Total (%)
Non-Fossil Fuel Sources (Renewables, Hydro, Nuclear)	256.09 GW	> 51%
Fossil-Fuel Sources (Coal, Gas, Diesel)	244.80 GW	~ 49%

Renewable Breakdown

1. Solar Power- 127.33 GW
2. Wind Power- 53.12 GW

Key Achievement- India has already achieved the COP26 Panchamrit goal of having 50% installed electric capacity from non-fossil sources by 2030, accomplishing these five years ahead of schedule.

Challenges in Green Hydrogen Production

Despite the ambitious targets, several structural and economic hurdles remain.

High Production Costs- Currently, Green Hydrogen is significantly more expensive to produce than "Grey Hydrogen" (produced from natural gas).

Infrastructure Deficit- Lack of a dedicated nationwide pipeline network. Reliance on expensive transport modes like trucks or rail.

Supply Chain Gaps- Limited domestic manufacturing of electrolysers. High import dependence for key components raises costs and vulnerability.

Grid Integration & Power Reliability- Electrolysers need a constant power supply to be efficient. Renewable energy (solar/wind) is intermittent, and energy storage remains costly. Grid instability in certain regions disrupts production.

1. Water Scarcity- Electrolysis requires high-purity water, creating potential conflict in water-stressed regions.
2. Financing Barriers- Projects are capital-intensive with long gestation periods, making traditional bank financing difficult.
3. Global Competition- India faces stiff export competition from established or emerging hubs in Europe, Australia, and the Middle East.

Government Initiatives to Address Challenges

The government has rolled out specific schemes to overcome the barriers mentioned above.

SIGHT Scheme (Strategic Interventions for Green Hydrogen Transition)

1. Duration- Valid up to 2029-30.
2. Objective- Provides financial incentives for the domestic manufacturing of electrolysers and the production of Green Hydrogen, aiming to lower costs and boost local supply chains.

Development of Green Hydrogen Hubs

Concept- Creating integrated centers for production, consumption, and export to minimize transport costs.

Designated Hubs (2025)- The Ministry of New and Renewable Energy (MNRE) recognized three major ports as nodal hubs-

1. Deendayal Port Authority (Gujarat)
2. V.O. Chidambaranar Port Authority (Tamil Nadu)
3. Paradip Port Authority (Odisha)

Standards, Certification, and Safety

Initiative- Green Hydrogen Certification Scheme of India (GHCI) launched in 2025.

Purpose- To certify hydrogen as "Green" based on a rigorous assessment of greenhouse gas emissions across the lifecycle.

Impact- Ensures transparency and credibility for global buyers.

Nodal Authority- The Bureau of Energy Efficiency (BEE) accredits agencies to monitor these projects.

Strategic Hydrogen Innovation Partnership (SHIP)

1. Nature- A Public-Private Partnership (PPP) framework.
2. Goal- To foster R&D and innovation.
3. Collaboration**-** Brings together government institutions, industry players, and academic organizations to develop globally competitive hydrogen technologies.

Source- https-//www.thehindu.com/business/energy-storage-green-hydrogen-to-fundamentally-reshape-indias-renewable-energy-ecosystem/article70443998.ece